A METHOD AND TOOL FOR CLOSED DIE FORGING

Field of the invention

The present invention relates to closed die forging in general and in particular the forging of wheel suspension safety elements in aluminium, for the automobile industry.

Technical background

The common method for closed die forging aluminium is inherited from classical steel forging. Two dies are mounted in a press, and are pressed vertically against each other impressing their form on a blank that lies there between. Each die includes a negative half imprint of the form of the finished product milled into the die material; the dimension of the imprint being corrected for the temperature of the blank and die tool. A brake surface is milled along the rim of each half form. When the die tools are pressed against each other to the end position, these brake surfaces form a gap or gutter of minimum 3 mm. The forge process is "kneading" the material, and properly executed it will provide a high strength aluminium alloy with very high endurance strength. Thus, forging is particularly suited for highly stressed components, e.g. in the wheel suspension of a car.

The classical forging process has four main drawbacks:

1. Comparatively large consumption of materials (much waste). The pressure build up in order to fill the tool form is created by braking the material in the gutter. The gutter is integrated into the die tool, and follows the movement of the dies. Thus, initially the gutter forms a very large gap. The large gap will allow an easy flow of material through the gutter. Only at the end of the press stroke sufficient pressure is created to fill the form. Waste of 30% is considered a very good result (weight of

waste material compared with the weight of the finished product).

2. The press force requirements are large. At the end of the press stroke, a large total working area (the surface of the product in addition to the area of the gutters) must be put under sufficient pressure to get the material flowing out of the gap between the dies.

3. Requirements for special lubrication fluids, in relatively large volumes. The material is squeezed from the centre of the tool and out through the brake gap/gutter with a steadily increasing pressure. There are large horizontal movements of material along the tool surfaces, which must be lubricated with special lubricating fluids in relatively large quantities.

4. The demanding requirements for centring the blank. A prerequisite for the process is that the material should flow freely in all directions. Thus, it is not possible to place stoppers/orienting pins in the tool. The blank must therefore be placed accurately in the press, e.g. with a robot.

Brief summary of the invention

It is an object of the present invention to provide a method and tool for closed die forging with less waste of raw materials compared with prior art methods.

Another object is to provide a method and tool for closed die forging which requires less press force.

Still another object is to provide a closed die forging method and tool in which large horizontal flow of material is avoided, thus making the requirements on lubrication less stringent.

Yet still another object is to provide a method and tool for closed die forging in which the blank is more or less self centring in the press.

These objects are achieved in a method and tool according to the appended patent claims. In particular the method includes closed die forging a product from a preform blank of a forgeable material by placing the blank in a press tool, said press tool including a number of centre and side members surrounding the blank, closing the press tool upon the blank, and forging the blank with short horizontal and vertical movements of the tool avoiding large horizontal movements in the material.

The tool for forging a blank into a product according to the method in claim 1 includes a number of upper (21) and lower (22) centre members, and first (23, 24) and second (25, 26) side members, said first (23, 24) and second (25, 26) side members enclosing said upper (21) and lower (22) centre members defining a closed cavity with the form of product.

Brief description of the drawings

The invention will now be described in detail in reference to the appended drawings, in which

Fig. 1 is an illustration of a classical forge process according to prior art, shown in four subsequent steps,

Fig. 2 is an illustration of the inventive forge process, shown in three individual steps,

Fig. 3 A - C shows details of the inventive forge process,

Fig. 4 shows a detail of the corresponding process of forging components of large width,

Fig. 5 shows typical cross sections of components manufactured with the new process and the prior art process.

Detailed description of the invention

The classical prior art forging process is illustrated in Fig. 1. In the first step, Fig. 1A, a preform blank is placed between the dies of a press. When force is applied, Fig. 1B, the material in the blank will start to fill the form of the dies. Some material will flow horizontally out of the die tool. Fig. 1C shows how this process continues as the die tool closes. At the end of the press stroke, Fig. 1D, the material of the blank fills the die form completely, with a rim of superfluous material protruding out of the gutter. In a subsequent step, this rim is removed. The amount of material that must be removed, can be equal to the weight of the finished article, i.e. 50% of the material in the preform blank is wasted.

In the new, inventive forge process, illustrated in Fig. 2A - C, a redesigned forge tool is used. The tool includes an upper 21 and lower 22 centre member, and first 23, 24 and second 25, 26 side members. Each side member consists of an upper part 23, 25 and a lower part 24, 26. The side members are equipped with a sloping outer surface. Two press members 27 and 28 having mating sloping surfaces are acting on the side members. When moving the press members vertically, their movement is translated into a corresponding horizontal movement of the side members. In the horizontal plane, the forms of the inner surface of each side member will closely follow the forms of the upper and lower centre members. Thus, when the side members are brought completely together, the tool will form a closed unit. The whole assembly rests on a table 29.

Initially, the blank 20 is placed between the centre members 21, 22 clamping the blank in position. Then, the side members 23, 24 and 25, 26 are closed upon the blank. By

this arrangement, it is not necessary to place the blank with great precision, as the tool itself will align the blank in a correct position when the side members close upon it.

In the first forge step, Fig. 2B, the press members 27, 28 are forced downwards until they butt against the table 29. This results in a horizontal movement of the side members, which will upset the ends of the blank. The side members will close against the centre members. The material in the blank is pressed horizontally from the ends into the die form, which will become about 2/3 filled.

Synchronously, or when the horizontal movement is finished, the centre members are forced together squeezing until the material has filled the rest of the form. This step is illustrated in Fig. 2C. Due to the small width of the centre members, a relatively small press force is required compared with the prior art forge method.

In this embodiment of the inventive forge process, a small fixed brake gap may be employed, in the range of 0.5 - 1.0 mm. The brake gap is mainly included in order to allow the form to be filled completely, while taking care of small differences in the volume of the blank. The amount of waste material is negligible. However, an additional step is needed for removing the rim of waste material.

In the embodiment shown in Fig. 3 A - C, the brake gap is dispensed with altogether. The figures show only a detail of the tool.

In Fig. 3A, the tool has just been closed. The side member includes no gutter, and is shaped like a blunt wedge. When force is applied this blunt wedge will engage the blank; the blank will become upset at the rim and start filling the cavity in a proper way, as illustrated in Fig. 3B. In Fig. 3B the horizontal movements have been completed. The

material in the blank has been upset at the rim, and now partially fills the cavity formed by the side members. By using side member of this particular shape, one is assured that the blank is upset at the correct place. Else, the upsetting action could start at any point along the blank, e.g. in the middle, preventing the material filling the cavity as it should.

In Fig. 3C also the vertical movements have been completed. The material from the blank now nearly completely fills the cavity. Only small interstices remain. Tolerances as to the volume of the blank will be taken care of by these voids.

In case the width of the product exceeds about 30 mm, the centre members must be divided into several sub-members, as illustrated in Fig. 4. Thus, the central part of the product will form ribs or a honeycomb pattern in order to achieve sufficient "kneading" without large horizontal movements of material during the second step of the forging process. The figure shows a detail of the finished product.

In Fig. 5 is shown typical sections from a broad component forged according to the classical method (right; rim of waste material removed), and according to the new inventive method (left).